

# THE WEATHER AND CIRCULATION OF AUGUST 1954<sup>1</sup>

## Including a Discussion of Hurricane Carol in Relation to the Planetary Wave Pattern

JAY S. WINSTON

Extended Forecast Section, U. S. Weather Bureau, Washington, D. C.

### PERSISTENCE OF THE WEATHER REGIME

The weather experienced over much of the United States in August 1954 was basically similar to the prevailing weather regime of the two preceding summer months [1,2.] August temperatures were greater than normal over a large section of the country extending from the Rockies to the Atlantic coast, while cooler-than-normal weather prevailed along the northern tier of States and in the Far West (Chart I-B). Precipitation east of the Rockies was mostly subnormal where warm weather prevailed, but was in excess of normal near the boundary zone between above and below normal temperatures (Chart III). These weather patterns were essentially characteristic of the entire summer of 1954, as is clearly demonstrated by the close similarity of Charts I-B and III-B to the seasonal temperature and precipitation anomalies portrayed in figure 1. For about three-quarters of the Nation the summer of 1954 was mainly hot and dry. In sharp contrast the west coast, the Northwest, and the Northeast experienced a summer which was predominantly cool and wet.

Going somewhat farther afield, Great Britain and adjacent portions of northwestern Europe suffered through a summer that was cold, cloudy, and wet—a spell of bad weather which had set in as early as May. Long spells of

weather, especially in the summer season, are not uncommon in Great Britain according to a recent study by Lamb [3]. For the United States, Namias [4] has demonstrated that the maximum monthly persistence of temperature occurs between July and August with relatively high persistence also apparent between June and July. Precipitation and the circulation pattern also persist in summer, but to a lesser extent than temperature. The remarkable fact about this summer was that persistence of temperature, precipitation, and circulation was much more pronounced than usual.

### THE CIRCULATION PATTERN OF AUGUST 1954

Over the United States the mean circulation pattern at 700 mb. during August 1954 (fig. 2) again consisted of deeper-than-normal troughs near each coast and a stronger-than-normal continental anticyclone dominating the southern half of the country. This continental anticyclone, with center over Alabama in August, first developed in June [1], persisted through July [2], and even by the end of August still prevailed over the central United States. The central anomaly of this anticyclone (+110 feet) was slightly greater this month than it was in the two preceding months. The association of such a stronger-than-normal upper level anticyclone with summertime

<sup>1</sup> See Charts I-XV following p. 247 for analyzed climatological data for the month.

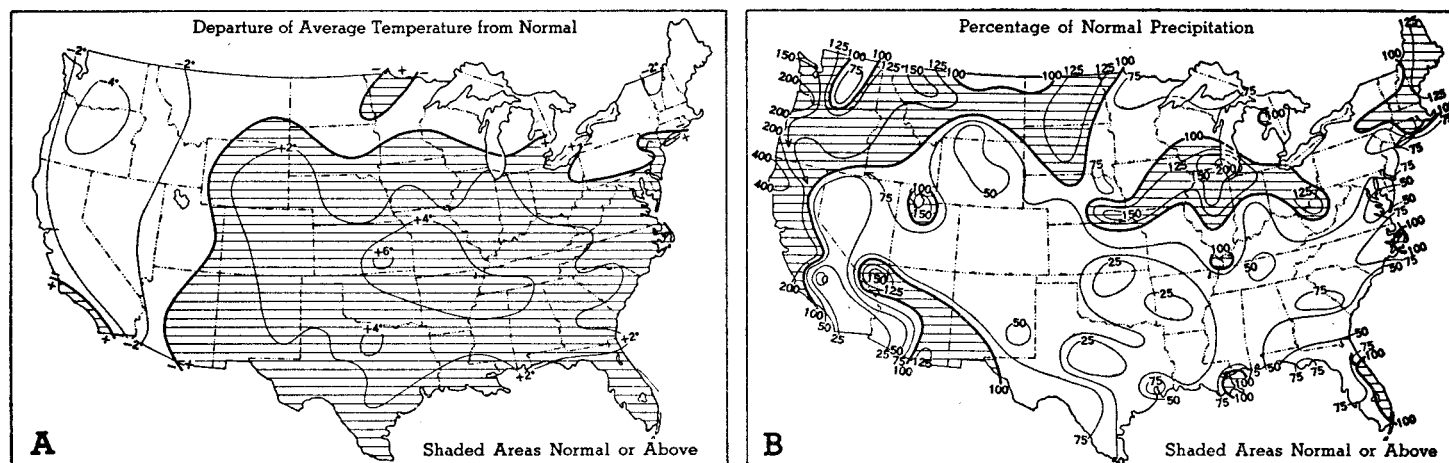


FIGURE 1.—(A) Departure of average temperature from normal, and (B) percentage of normal precipitation, both for the summer (June–August) of 1954. Most outstanding was vast area of country with hot, dry weather.

heat and drought over the United States has been pointed out many times since the early findings of Reed [5]. This relationship was again discussed in connection with the heat and drought of the preceding two months of this summer by Holland [1] and Hawkins [2].

Associated with this persistence of the circulation pattern over the United States was a general persistence in location and intensity of the five planetary troughs in the circulation of the Northern Hemisphere at middle latitudes. (Compare fig. 2 with fig. 1 of [2].) In each of these troughs heights were below normal this month, but in only two of the ridges in this wave train, those over Siberia and the eastern Pacific, were heights consistently

above normal at middle latitudes. Over the region from the trough along the west coast of the United States eastward to the trough along the 70° E. meridian, channels of negative height anomaly extended zonally through the ridges and connected the negative height anomaly centers located in the troughs. The channel across the northern United States was weakest since the continental ridge was still above normal as far north as the southern end of the Great Lakes, but this represented a considerable drop in anomaly in this region from the predominantly positive anomalies of July. From these considerations then the wave pattern during August could be characterized as one of large amplitude over Siberia and the Pacific

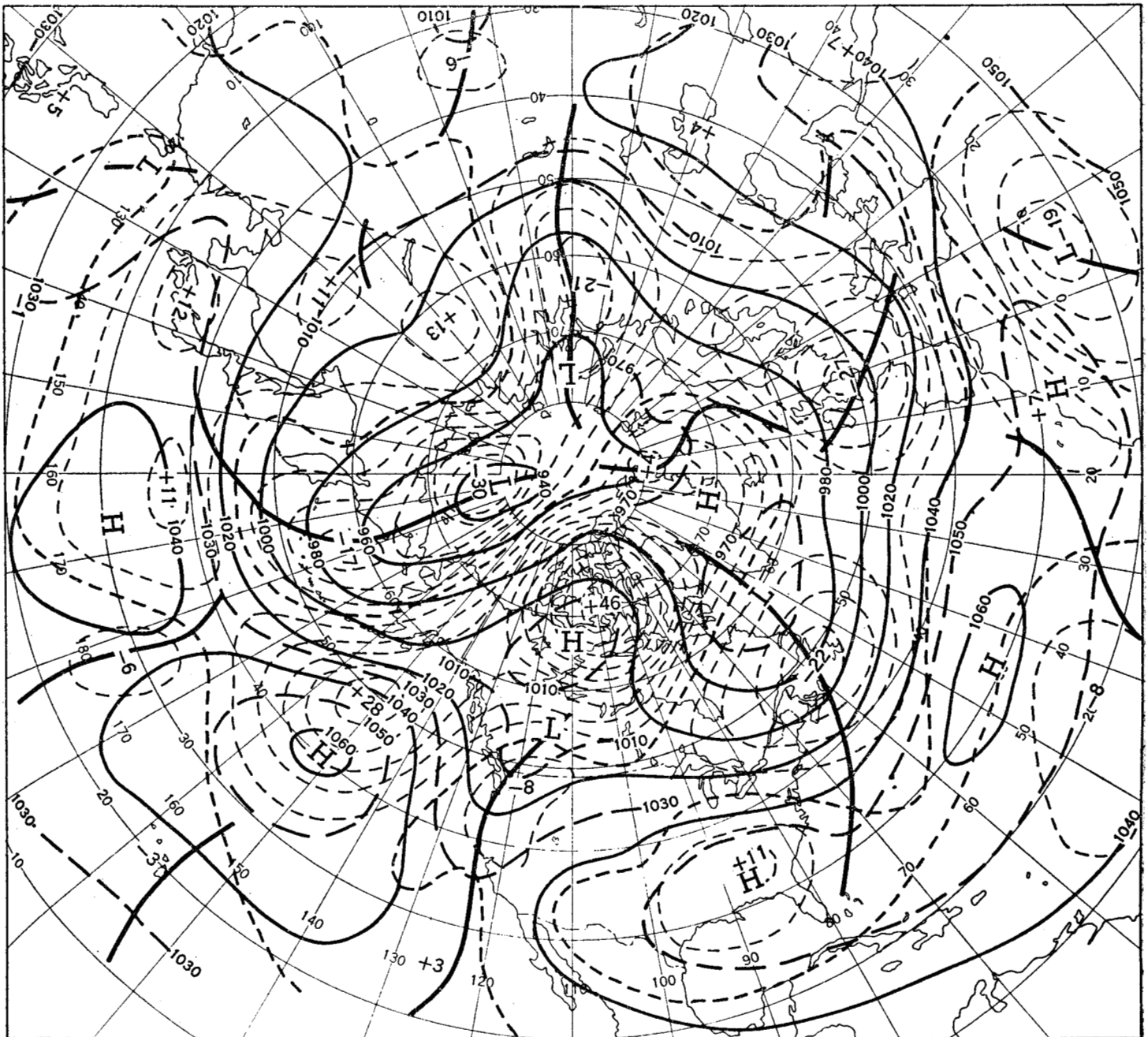


FIGURE 2.—Mean 700-mb. contours and height departures from normal (both in tens of feet) for July 31–August 29, 1954. Over North American area major circulation features were deeper-than-normal troughs along each coast with stronger-than-normal continental anticyclones over northern Canada and southern United States. Height anomaly of +460 feet over Canada is largest ever observed in August.

while relatively small amplitude waves covered the United States, the Atlantic, and Europe even though the troughs were deep.

Closely associated with these small amplitudes engendered by weak subtropical ridges at middle latitudes was an extensive anticyclonic circulation which covered most of the higher latitude sections (north of  $55^{\circ}$ – $60^{\circ}$  N.) of the Western Hemisphere. The major center of this anticyclone was located over northwestern Canada while a minor High cell was located over Greenland. Heights were considerably above normal throughout all of northern Canada, Greenland, and eastern Alaska. The maximum anomaly center of +460 feet located to the northeast of the Canadian High is the largest height anomaly (without regard to sign) that has ever been observed in any part of the Northern Hemisphere in the entire set of 700-mb. charts for August (back to 1933). This extensive high-latitude anticyclone and the channels of negative height anomaly to its south are typical features of very large-scale blocking activity which often dominates large portions of the circulation. Such large-scale blocking has been especially prevalent so far this year having already appeared in conspicuous form over the Western Hemisphere during several months of 1954 [1, 2, 6, 7, 8].

The effects of high-latitude blocking on the geostrophic wind field at 700 mb. are readily apparent in figure 3. Note the split in the westerly current over the eastern Pacific and North America with a weak branch of the flow around the northern periphery of the High in the Canadian Arctic (fig. 3A). The main branch of the westerlies, however, dipped southward through the trough along the west coast of the United States and then traversed the northern portion of the country and the central Atlantic, roughly centered along the  $45^{\circ}$  N. latitude circle. This small latitudinal variation of the axis of maximum wind speed is an obvious reflection of the small amplitude of the waves and the zonal channel of negative height anomaly already pointed out in figure 2. This westerly belt was more intense and located farther south than normal throughout the zone from the west coast of the United States eastward to Europe. Thus, as shown in figure 3B, wind speeds were markedly above normal south of about  $50^{\circ}$  N. throughout the United States and the Atlantic, while winds were much weaker than normal over most of Canada and northern sections of the Atlantic, where the normal westerlies were virtually absent in the presence of high-latitude blocking.

It is interesting to note that the westerlies in the Pacific area were also generally stronger than normal, but they were located farther north than normal, contrary to the situation over the United States and the Atlantic. This type of regional difference in the westerlies is frequently observed when pronounced blocking occurs since blocking usually does not dominate all portions of the Northern Hemisphere at one time. This was noted during the intense index cycle of February 1952 [9]. A recent case of westerlies north of normal over the Pacific and south

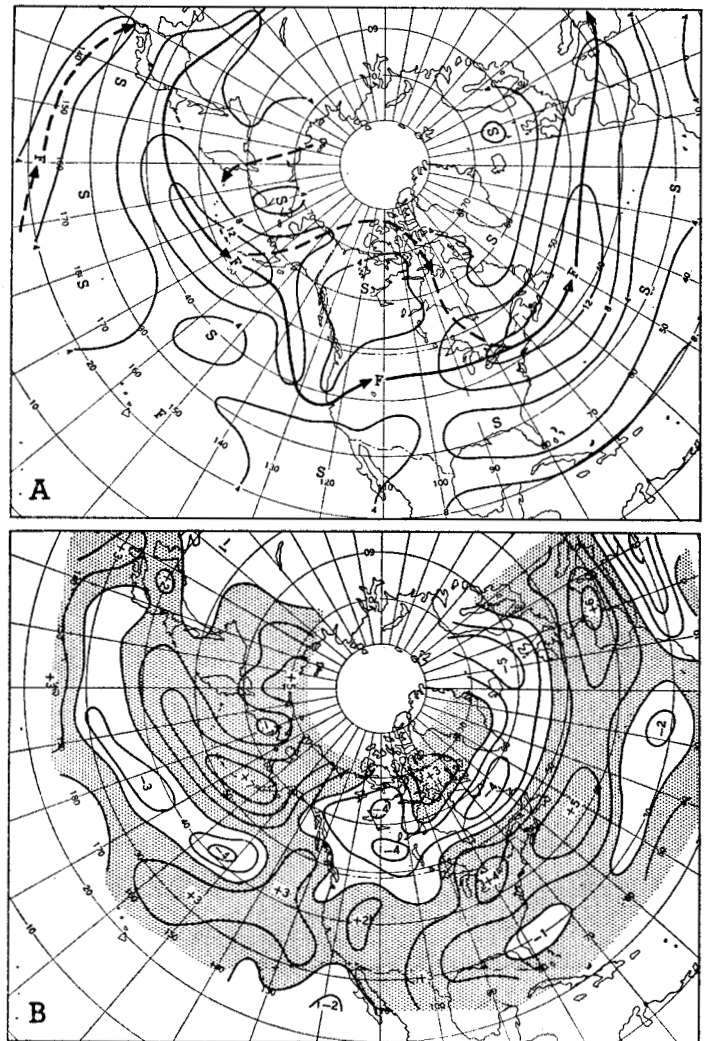


FIGURE 3.—(A) Mean 700-mb. isotachs and (B) departure from normal wind speed (both in meters per second) for July 31–August 29, 1954. Solid arrows indicate major axis of maximum flow, while dashed lines show secondary axes of fast flow. Note split in westerlies associated with blocking over North America and zonal jet axis across eastern United States and Atlantic where winds were considerably stronger than normal.

of normal over North America and the Atlantic occurred in May 1954 (cf. fig. 4 of [8]).

The wind field and other major features of the circulation at 200 mb. (fig. 4) were very similar to the features already discussed at the 700-mb. level. The axis of maximum winds at 200 mb. coincided almost exactly in position with the 700-mb. axis over the entire region shown in figures 3A and 4. Perhaps the only significant difference in the wind fields was the axis of southwesterly flow at 200 mb. originating from lower latitudes in the eastern Pacific and joining the main jet stream over California. This had no counterpart at 700 mb. It was essentially related to the shrinking in size of the eastern Pacific anticyclone with height and the accompanying general enlargement and extension southwestward of cyclonic circulation at higher levels in the trough off the west coast of the United States. In contrast to the weakening of the oceanic anticyclonic circulations with height (note the disappearance of the Atlantic High center altogether) both anti-

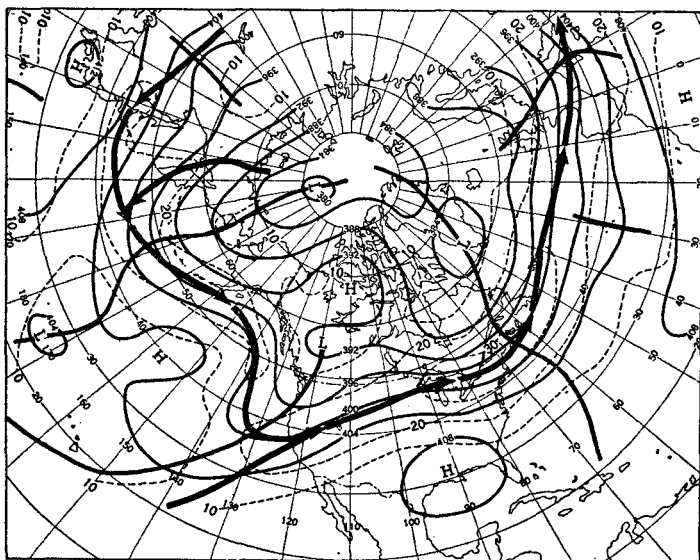


FIGURE 4.—Mean 200-mb. contours (in hundreds of feet) and isotachs (dashed, in meters per second) for July 31–August 29, 1954. Solid arrows indicate the axes of monthly mean jet stream. Circulation pattern and jet axis are very similar to 700-mb. features of figures 2 and 3A except for increased cyclonic circulation and southwestward tilt of west coast trough.

cyclones over continental North America, the one in northwestern Canada and the other over the southern United States, maintained their strength at the 200-mb. level. These are most likely manifestations of the differences in the tropospheric temperature fields between continents and oceans in summer.

#### CIRCULATION RELATED TO TRACKS OF CYCLONES AND ANTICYCLONES, FRONTS, AND WEATHER

The greatest concentration of cyclonic activity in the Western Hemisphere during August 1954 occurred in a relatively narrow zone extending from the northeast coast of the United States out into the east-central Atlantic between latitudes  $45^{\circ}$  and  $50^{\circ}$  N. (fig. 5A and Chart X). This major storm track was located on the average about  $3^{\circ}$  of latitude north of the axis of maximum winds at 700 mb. (fig. 3A). It also coincided closely with the zonal axes of negative height and pressure anomalies at 700 mb. (fig. 2) and sea level (Chart XI inset), respectively. Several of these storms moved on eastward and northeastward from the edge of the analyzed data in figure 5A across the British Isles, generally deepening and slowing down in the vicinity of the  $-270$ -foot height anomaly center at 700 mb. (fig. 2). The more normal track of cyclones just south of Greenland was somewhat secondary this month, but several storms crossing the Atlantic at these higher latitudes moved southeastward across Great Britain and also contributed to the persistent cyclonic activity which afflicted the British Isles and adjacent areas.

Another major seat of cyclonic activity this month was located over the northwestern United States and the eastern slopes of the Continental Divide as far south as the Oklahoma Panhandle (fig. 5A). Most of these cyclones

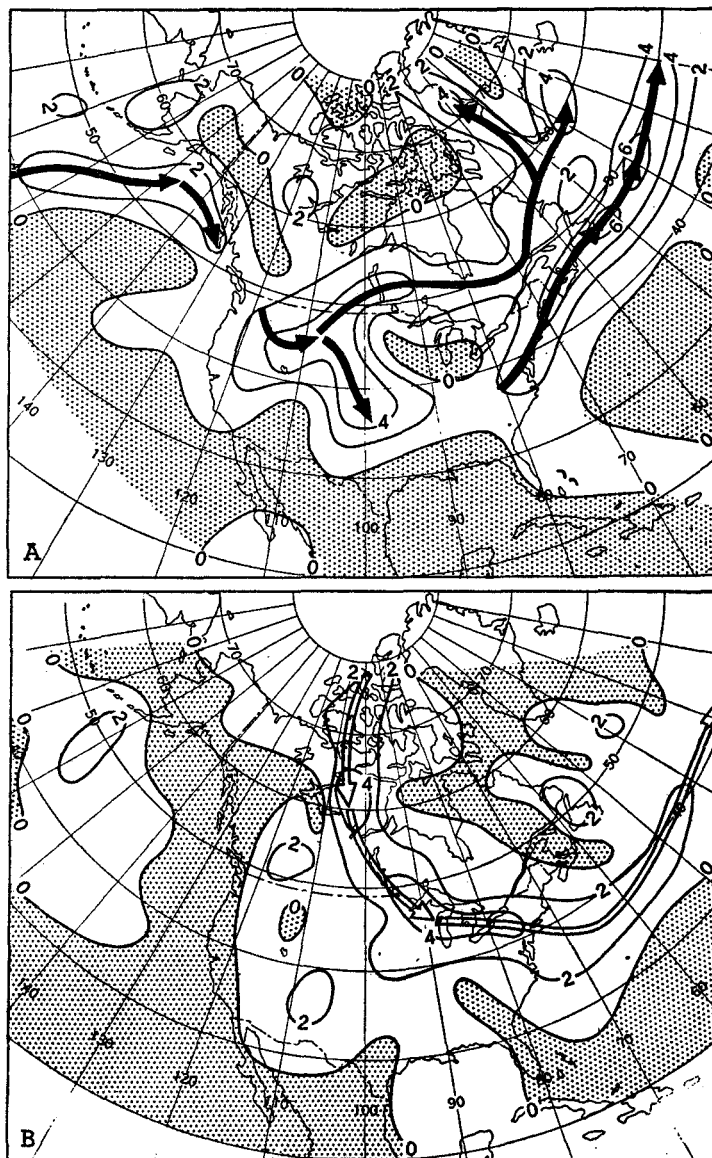


FIGURE 5.—Frequency of (A) cyclone passages and (B) anticyclone passages (within  $5^{\circ}$  squares at  $45^{\circ}$  N.) during August 1954. Well-defined cyclone tracks are indicated by solid arrows and anticyclone tracks by open arrows. Outstanding feature of anticyclones was well-established principal track of polar Highs originating over Canada and passing over Great Lakes and Middle Atlantic States into the Atlantic. Cyclonic activity was frequent in western United States, but few major storms moved across central and eastern North America due to the strength of continental anticyclones shown in figure 2.

formed over the Plateau, to the east of the deeper-than-normal trough along the West Coast which tilted inland toward Alberta in its northern portion (fig. 2). Most of the storms could be traced to cold fronts and accompanying weak waves which drifted down the Pacific Coast from the Gulf of Alaska around the northern and eastern peripheries of the Pacific High. Apparently the anticyclonic circulation in this ridge was so strong that major storm centers were prevented from passing through the Gulf of Alaska.

The prevalence of the west coast trough and the associated cyclones in the West produced more precipitation than normal along the Pacific coast and in the Northwest (Chart III). Meanwhile the strong northerly fetch of

air off the west coast associated with the large amplitude of the wave upstream from the trough (fig. 2) brought cold Pacific air masses into and through the trough. These air masses were prevented from warming appreciably over the West because of the prevailing cyclonic circulation so that temperatures for the month averaged well below normal with departures of more than  $4^{\circ}$  F. over much of Nevada, California, and Oregon (Chart I-B). Along the immediate Pacific coastal regions temperature anomalies were small or even positive, as normal sea-breeze effects were minimized because of the lessened temperature contrast between ocean and continent brought about by the cold air inland.

The depressions over the West drifted across the Continental Divide and the majority moved slowly south-eastward, often becoming nearly stagnant over western Kansas and vicinity where average sea level pressures were as much as 4 mb. below normal (Chart XI inset). With the exception of one cyclone, none of these centers managed to move eastward from Kansas. Apparently they were unable to survive once they approached the region of the continental ridge with its marked anticyclonic circulation aloft. However, some of the perturbations associated with these cyclones did finally manage to move eastward as weak stable waves on the polar front along the northern periphery of the continental High.

Another storm track branched northeastward from Montana, and this one also became diffuse as it crossed the middle of the continent (fig. 5A). Inspection of Chart X indicates that several of these storms over Canada and the Davis Strait were affected by the blocking anticyclone over northern Canada (fig. 2) and the weaker-than-normal westerlies to its south and east (fig. 3). Note that these cyclones often performed loops, made sharp turns, and moved slowly, as is characteristic of systems under the influence of weak steering currents associated with blocking Highs.

The huge mean anticyclone over northern Canada which had a closed center at sea level (Chart XI), 700 mb. (fig. 2), and 200 mb. (fig. 4) was quite naturally the seat of pronounced anticyclogenesis during August. Several of these developing Highs moved slowly or stagnated over northern and central Canada (Chart IX). From this region strong polar Highs followed a well-defined track south-southeastward to the Great Lakes and thence southeastward across the Middle Atlantic States into the Atlantic (fig. 5B), closely paralleling the mean 700-mb. flow (fig. 2). These anticyclones brought frequent outbreaks of cool continental polar air into the entire northern portion of the country eastward from the Dakotas so that temperatures averaged below normal (Chart I-B). In the first half of the month, blocking action was so pronounced over North America that rather deep penetrations of cold air into the southern United States occurred. These occasional major influxes of cold air were responsible for amelioration of the extreme heat over the South Central States in August as compared with July.

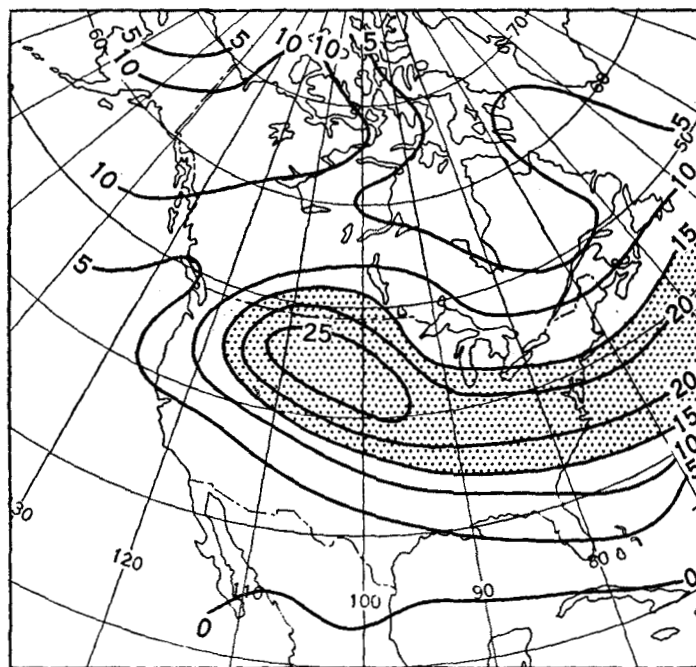


FIGURE 6.—Number of days in August 1954 with surface fronts of any type (within squares with sides approximately 500 miles). Frontal positions taken from *Daily Weather Map*, 1:30 p. m. EST. Note pronounced belt of frequent occurrence of fronts extending from middle Atlantic coast west-northwestward to Montana and Idaho. Heavier-than-normal precipitation occurred on northern side of this zone while markedly subnormal amounts occurred to the south (see Chart III).

For the most part, however, the southward drive of cold air masses was generally stopped about halfway down through the United States east of the Plains, because of the prevailing subtropical continental anticyclone aloft over the South. The boundary zone between the polar air and the tropical air was generally very well marked and tended to persist in much the same region throughout the month. This is clearly indicated in figure 6 which shows a pronounced concentration of fronts in a nearly zonal belt across the country from the middle Atlantic coast through the Ohio Valley and the Central Plains to the northern Rockies. This strong concentration of fronts provides a clear explanation for the general appearance of the monthly precipitation anomalies shown in Chart III. Since the fronts were largely aligned east-west, paralleling the axis of maximum frontal frequency, it is not at all surprising that rainfall amounts in excess of normal were located on the north side of this frontal concentration where overrunning took place, while amounts far below normal generally prevailed south of the frontal zone and throughout most of the area of the South dominated by the aforementioned continental anticyclone.

#### HURRICANE CAROL IN RELATION TO THE PLANETARY WAVE PATTERN

On the last day of August 1954 a devastating hurricane, designated as "Carol," moved rapidly up the Atlantic Coast and went inland over New England through

Rhode Island, eastern Massachusetts, and New Hampshire. In many respects this storm was similar to the infamous New England hurricane of September 1938, although the latter was somewhat larger and more intense [10]. The details of the destruction in lives and property caused by hurricane Carol as well as the details of the storm's motion have been covered rather completely by press, radio, and television. A good summary of the storm has also been prepared by McGuire [11]. The treatment of this hurricane in this article is designed to demonstrate how its behavior was governed, at least in a gross sense, by some interesting developments in the large-scale circulation. This type of "control" of tropical disturbances by the planetary circulation was pointed out in the case of the Florida hurricane of September 1947 by Klein and Winston [12].

The most notable features of Carol were its rapid acceleration and its unusual path right up along the coast, over the eastern tip of Long Island, and inland over New England instead of turning northeastward into the Atlantic. This acceleration and more northerly course of the storm were related to the development and intensification of a long-wave trough of large amplitude farther west over the eastern United States than it had been in the preceding few weeks. These large-scale circulation changes are illustrated by a series of three 5-day mean 700-mb. charts at half-week intervals in figures 7 to 9.

During the period August 21-25, 1954 (fig. 7), a large subtropical anticyclone (slightly east of the monthly mean position) dominated the circulation over the eastern two-thirds of the United States while a deep trough occupied the Far West. However, the wave amplitude in the Pacific had just increased and the deep trough in the central Pacific and the very strong ridge in the eastern Pacific were both retrograding at this time. A constant absolute vorticity trajectory computed in the mean northwesterly flow east of this ridge off the west coast indicated some retrogression and/or development for the west coast trough, the United States ridge, and the trough near the east coast.

By the next period, August 25-29, 1954 (fig. 8), the trough in the West had retrograded off the coast and the ridge over the United States had also moved westward some  $10^\circ$  of longitude. Note how heights began to fall over the eastern United States in response to the increase in cyclonic vorticity indicated by the vorticity trajectory from upstream in figure 7. By this time the hurricane had formed near the Bahamas and was moving very slowly northwestward (see path in fig. 9) in a region south of the main westerlies and north of the subtropical easterlies. This slow-moving tropical cyclone was reflected in the closed Low and mean trough in that area (fig. 8). A vorticity trajectory calculated in the southwesterly flow ahead of the west coast trough indicated slightly more retrogression for the ridge over the central United States, an intensifying trough along the east coast, and the buildup of a ridge in the western Atlantic. If these trends were

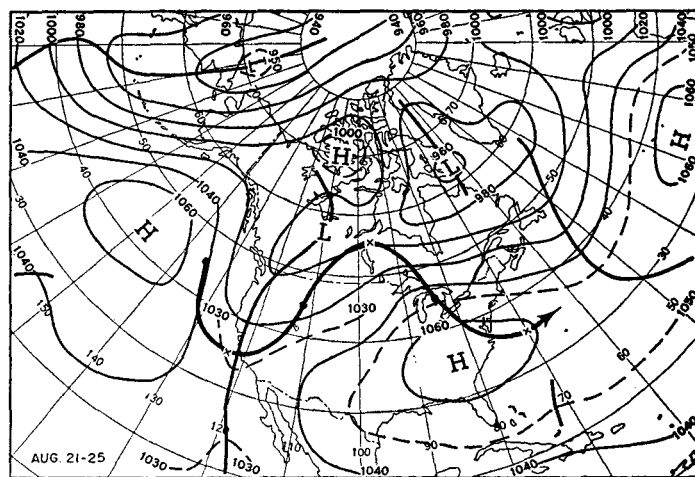


FIGURE 7.—Five-day mean 700-mb. contours (labeled in tens of feet) for August 21-25, 1954. Constant absolute vorticity trajectory originating in northwesterly flow east of large-amplitude ridge in eastern Pacific indicates retrogression and/or development of trough along west coast, ridge over eastern United States, and trough near east coast.

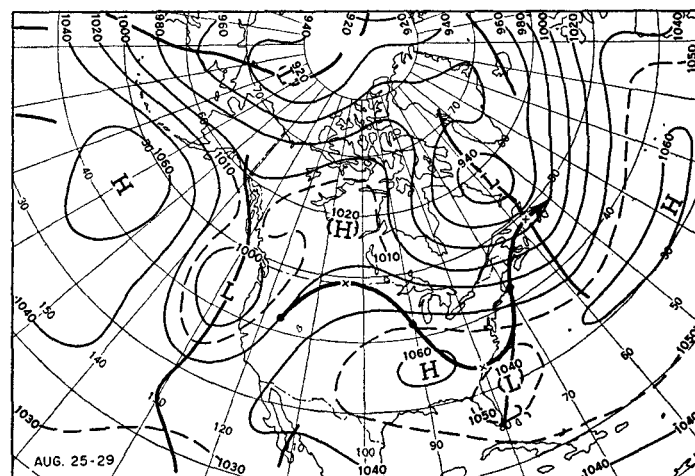


FIGURE 8.—Five-day mean 700-mb. contours (labeled in tens of feet) for August 25-29, 1954. Note retrogression of trough off west coast and ridge over United States as compared with previous map. Further retrogression of ridge, development of trough in eastern United States, and buildup of ridge over western Atlantic are indicated by constant absolute vorticity trajectory originating in southwesterly flow east of deep west coast trough. Note closed Low and trough off southeast coast associated with hurricane Carol.

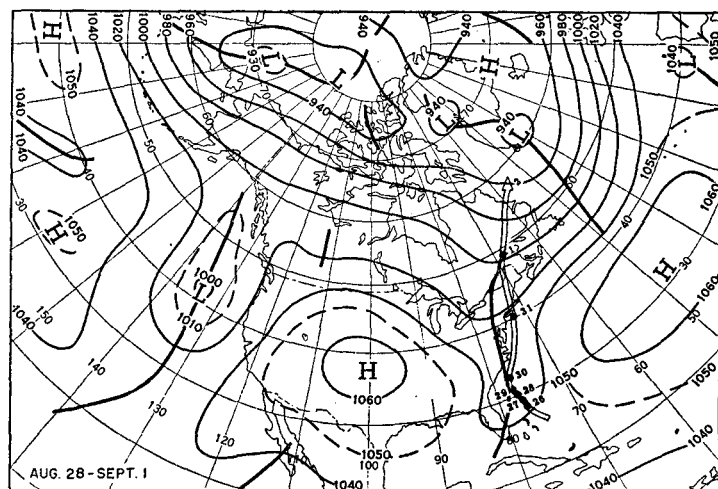


FIGURE 9.—Five-day mean 700-mb. contours (labeled in tens of feet) for August 28-September 1, 1954. Note path of hurricane Carol in relation to newly established trough along east coast. Further retrogression of west coast trough and United States ridge has occurred and ridge has built up over western Atlantic.

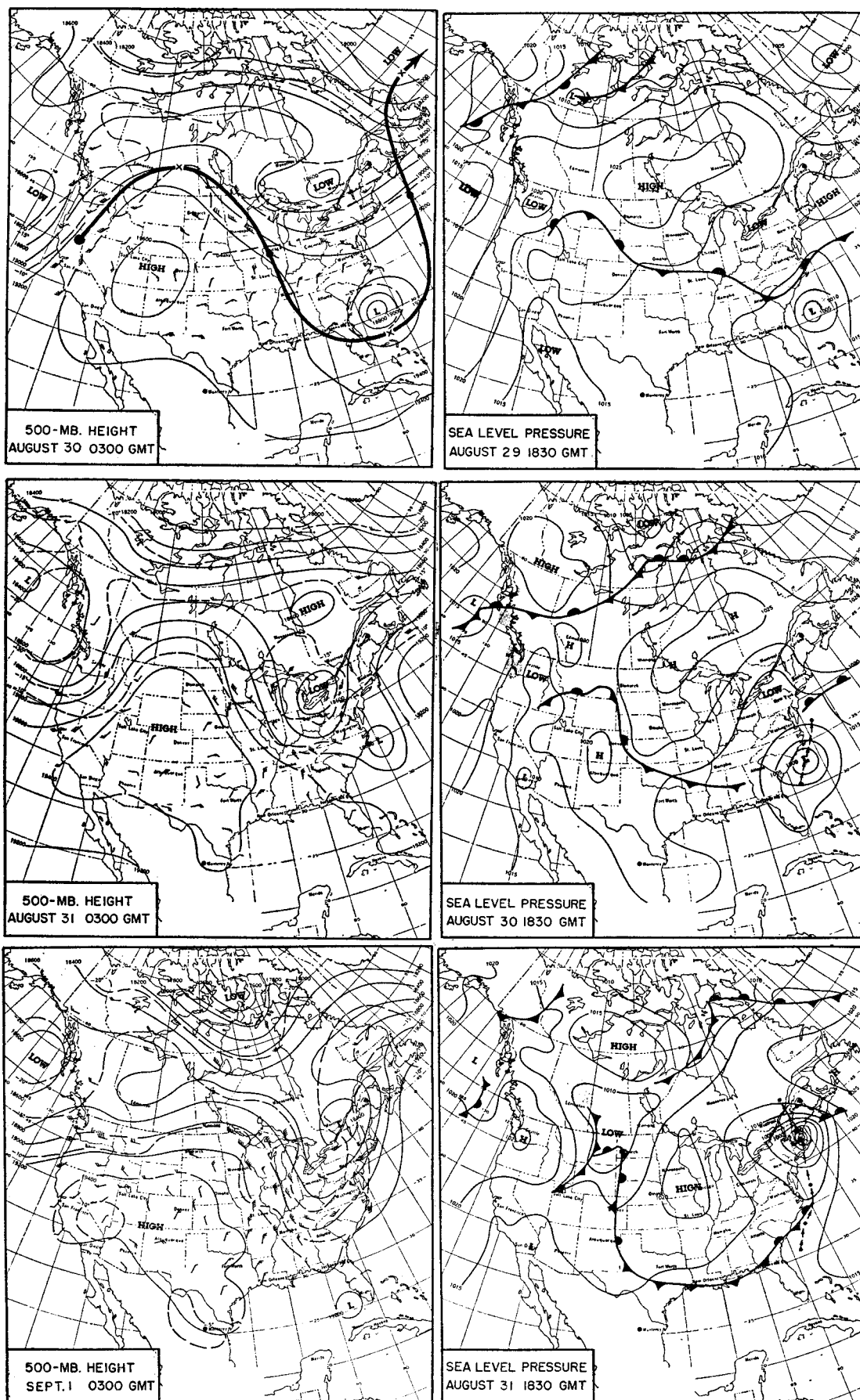


FIGURE 10.—Sequence of daily 500-mb. charts for 0300 GMT, August 30–September 1, 1954, and sea level charts for 1830 GMT, August 29–31, 1954, reproduced from *Daily Weather Map*. Track of hurricane Carol has been superimposed on sea level maps for August 30 and 31 with dots showing previous and subsequent 12-hourly positions relative to the 1830 GMT chart. Vorticity trajectory on 500-mb. chart for 0300 GMT, August 30, which is based on computation from spatially smoothed 500-mb. chart for this date, indicates continuing development of trough over eastern United States. Development of closed Low at 500 mb. over Lower Lakes and southerly components of flow to its east by 0300 GMT, August 31, indicate accelerating northward motion of hurricane close to or over east coast.

to continue, the tropical storm would soon come under the influence of a strong southwesterly current to the east of a newly developed long-wave trough of large amplitude over the eastern United States.

The next chart for August 28–September 1, 1954, covers the period during which the hurricane made its rapid trip up the east coast and across eastern New England (fig. 9). The path of the storm between August 28 and September 1 lay just to the east of and generally parallel to the newly established mean trough along the east coast. Note how the changes in circulation indicated by the vorticity trajectory of figure 8 generally worked out—viz, the continental ridge retrograding farther in the United States, the trough developing along the east coast, and a ridge also developing in the western Atlantic south of Newfoundland. There is little doubt that these straightforward developments in the 5-day mean wave pattern at middle latitudes, as illustrated in figures 7–9, were of primary importance in the life history of Carol following its initial stages of development near the Bahamas.

A more detailed history of Carol in relation to the upper-level wave pattern is given by the 3-day sequences of sea level and 500-mb. charts in figure 10. These charts are reproductions of printed maps appearing on the *Daily Weather Map*, and it should be noted that the 500-mb. charts are for a time  $8\frac{1}{2}$  hours later than the sea level charts. The track of the hurricane has been traced on the sea level charts for the 30th and 31st showing previous and subsequent 12-hourly positions.

On the 500-mb. chart for 0300 GMT, August 30, a vorticity trajectory has been superimposed to illustrate the continuing tendency for increasing trough development along the east coast as a result of vorticity flux from upstream. This trajectory was computed from a spatially smoothed 500-mb. flow field (for the same time) which is prepared routinely by the WBAN Analysis Center. This spatial smoothing technique was introduced by Fjørtoft [13] as part of his graphical method of numerical prediction.

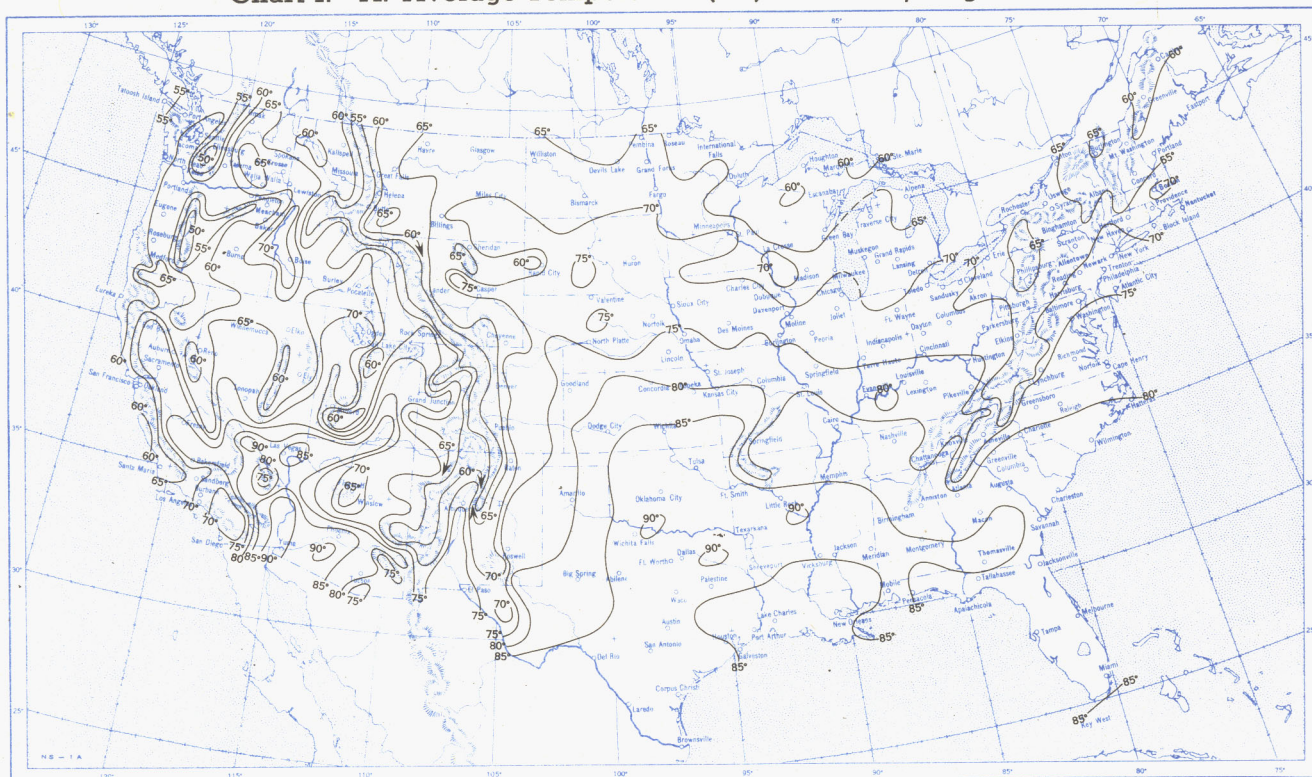
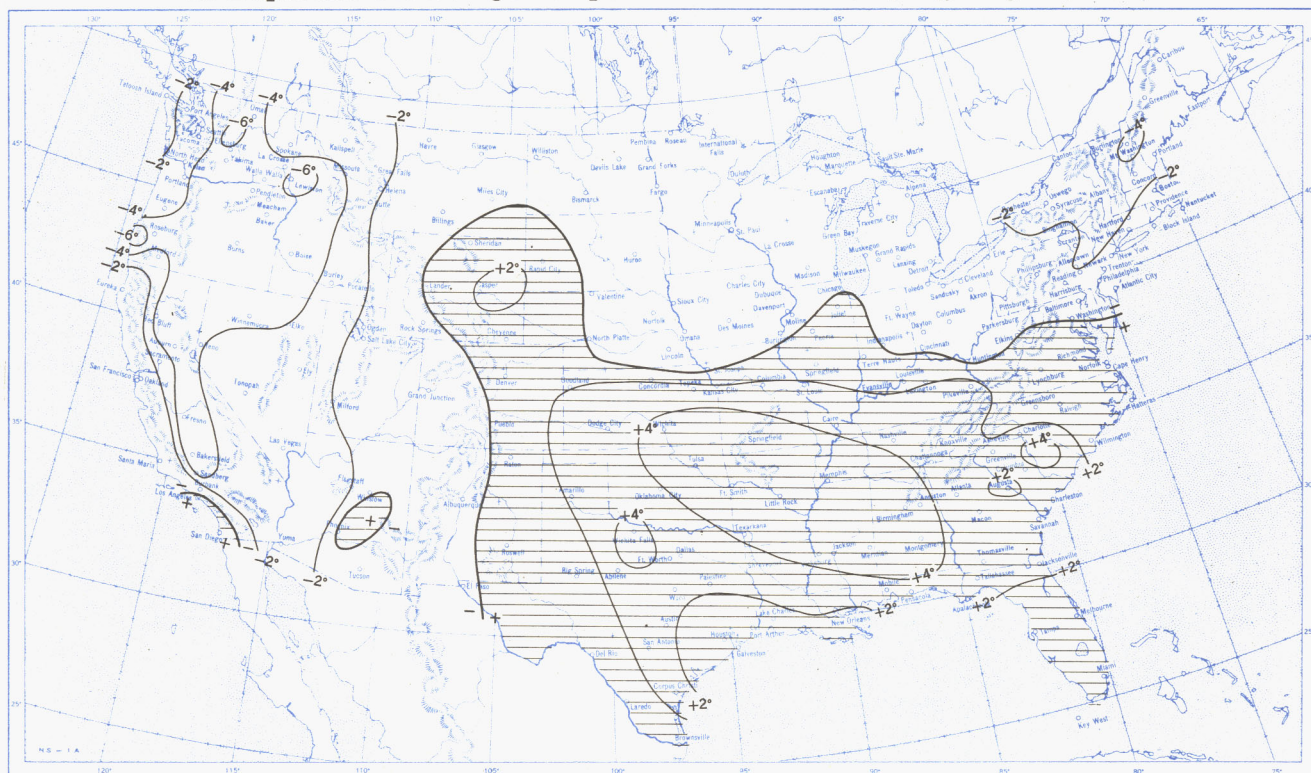
Perhaps of greatest importance in forcing the storm to turn northward through New England was the manner in which the indicated trough development took place over the East. Inspection of the charts with the concepts of vorticity advection in mind leads one to conclude qualitatively that a region of strong cyclonic relative vorticity (made up of both strong cyclonic shear and cyclonic curvature) near Lake Superior on the 30th was advected southeastward to form the Low over the Lower Lakes on the 31st. Also of importance in bringing about the closing-off of this Low center was the rather pronounced cresting of anticyclonic vorticity north of the Low in eastern Canada. Notable too was the fact that the ridge off the Atlantic coast built up almost simultaneously with the deepening of the Low over the Lower Lakes so that by 0300 GMT, August 31, strong southerly flow existed north of the hurricane center over the Northeast. With a deepening and slowly moving upper Low over the Lakes and the associated sea level center moving slowly eastward

across western New York, it would not be unexpected that a cyclone advancing up the east coast would accelerate rapidly and stay very close to the coast or even be steered inland. In fact, it is worth pointing out that in many of its basic features (i. e., intensification of a planetary trough, development of a deep upper-level cyclone center west of the Appalachians, and anticyclonic circulation cresting across the top of the Low through southeastern Canada) this situation was rather similar to several cases of recent years in which intense extratropical storms turned inland along the east coast (e. g., [14, 15]). Since some of these storms have been predicted rather well by numerical prediction methods [16], it is quite possible that numerical methods could be successfully applied in this case. It is understood that more detailed investigations of hurricane Carol are currently being pursued.

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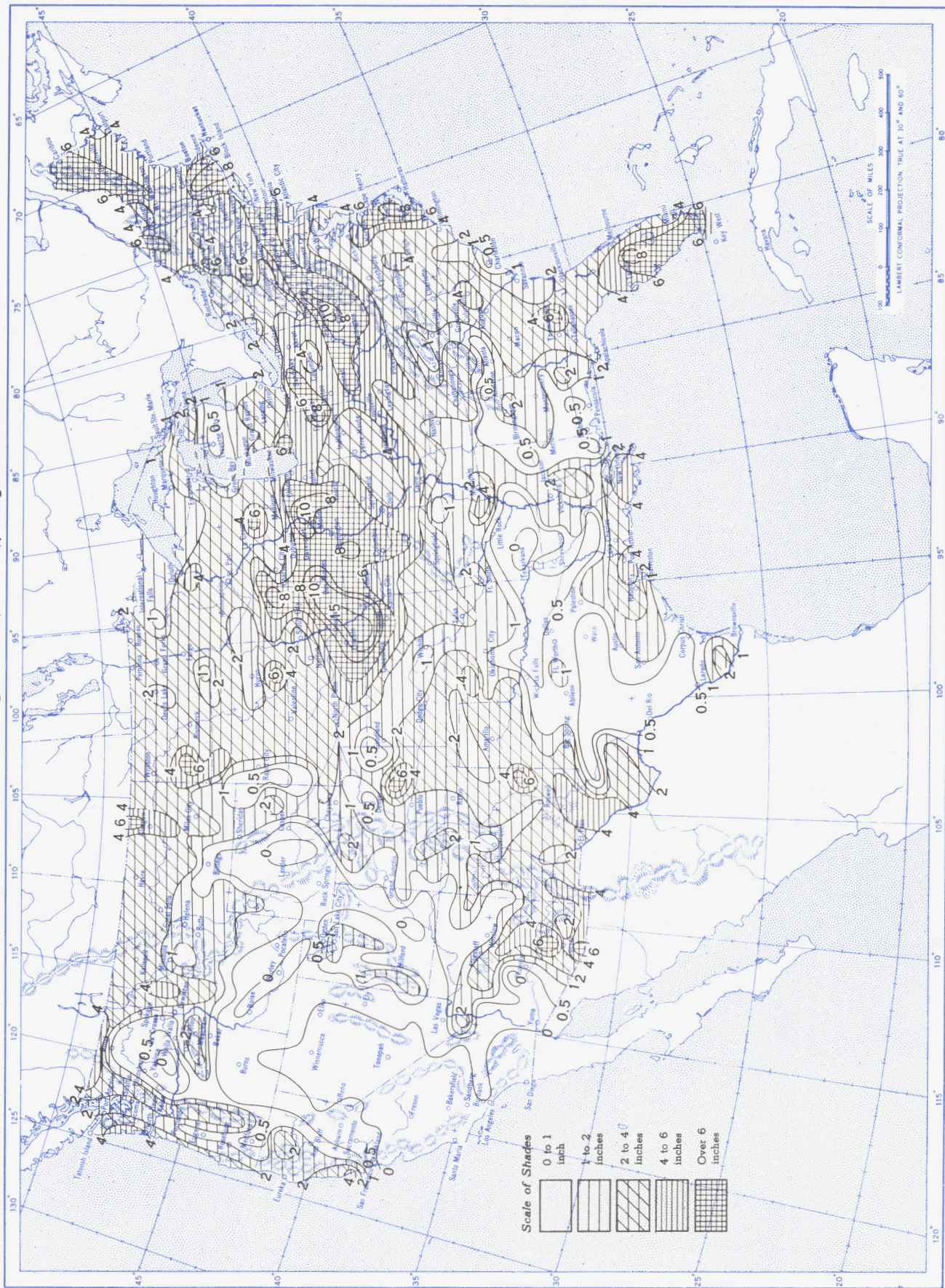
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Chart I. A. Average Temperature ( $^{\circ}\text{F.}$ ) at Surface, August 1954.B. Departure of Average Temperature from Normal ( $^{\circ}\text{F.}$ ), August 1954.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

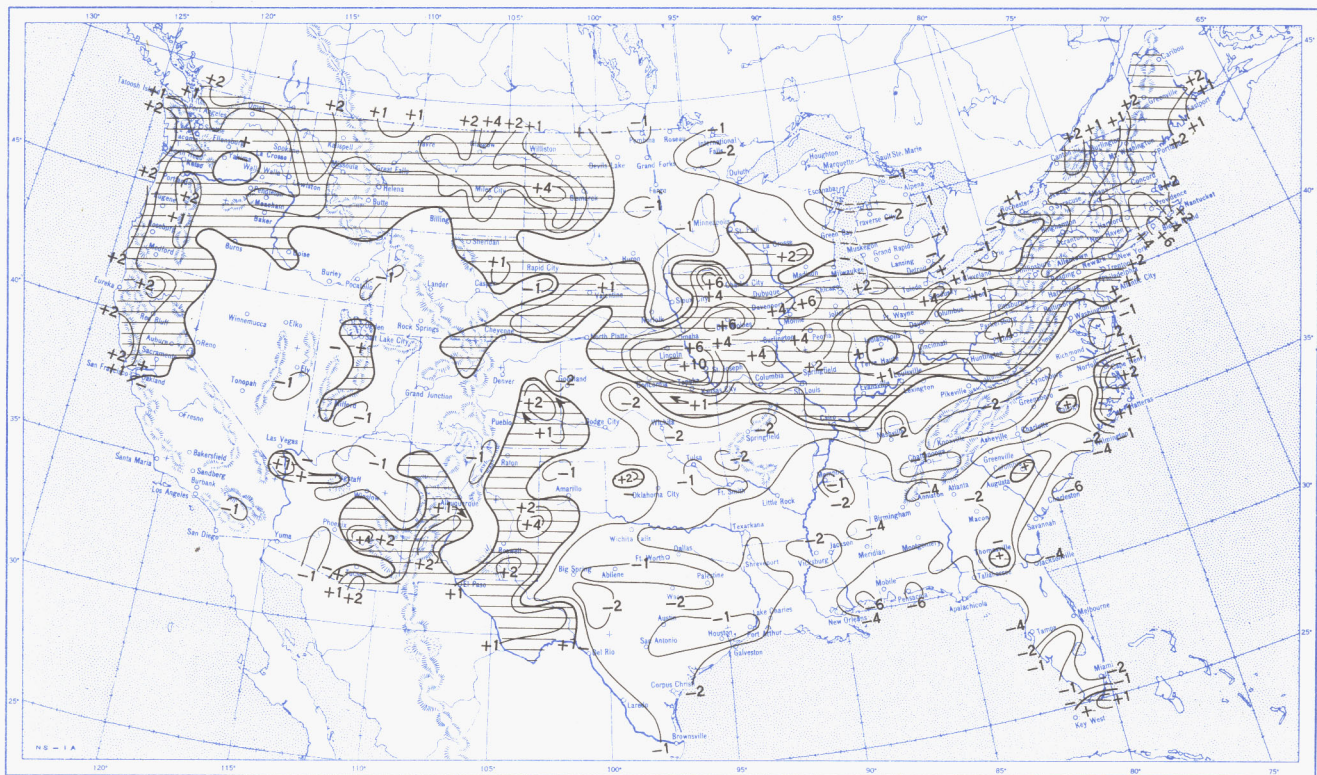
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), August 1954.

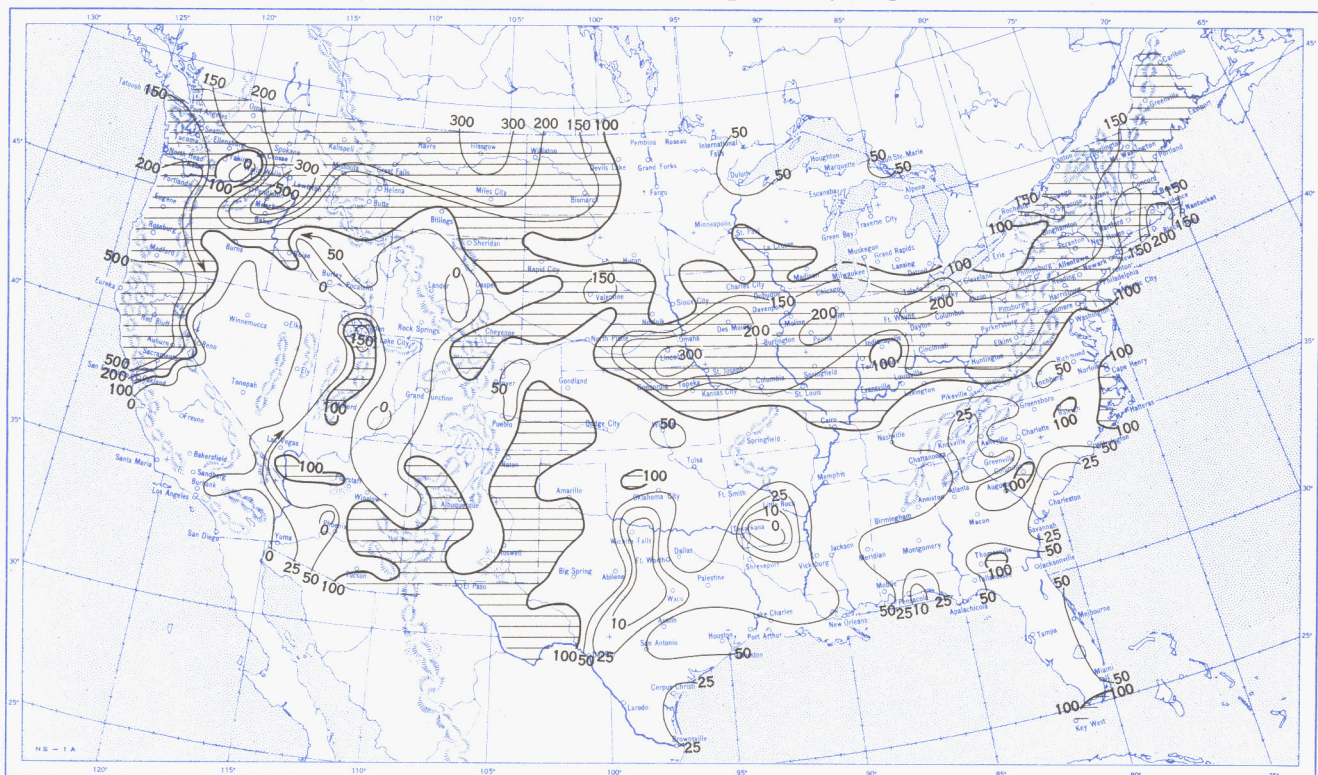


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), August 1954.

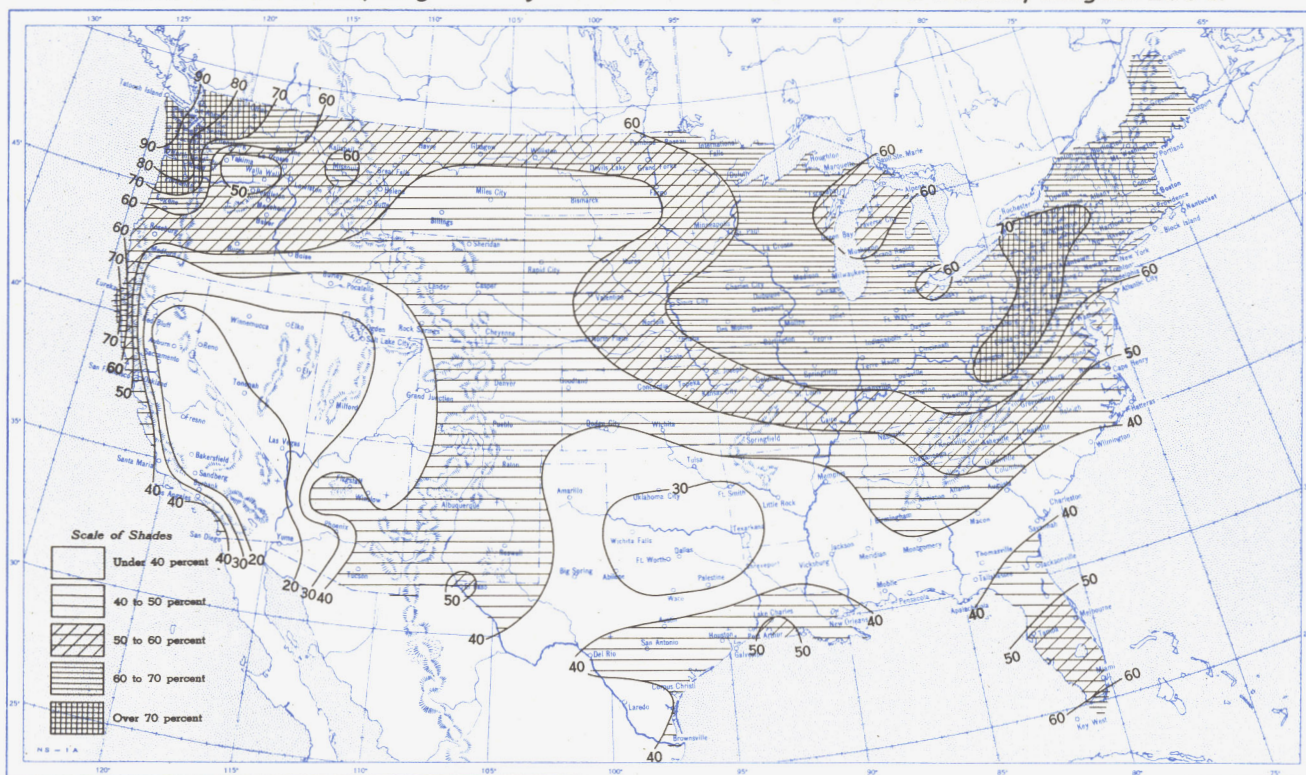


B. Percentage of Normal Precipitation, August 1954.

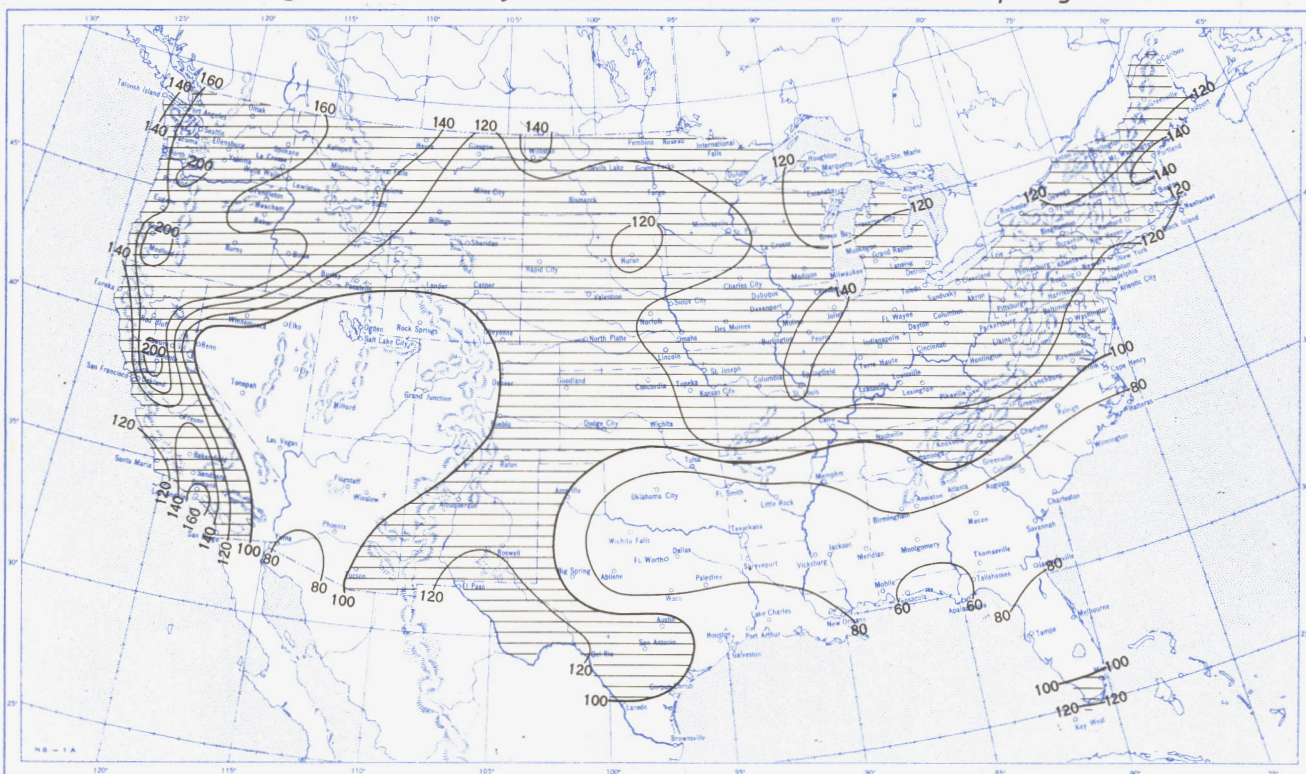


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, August 1954.

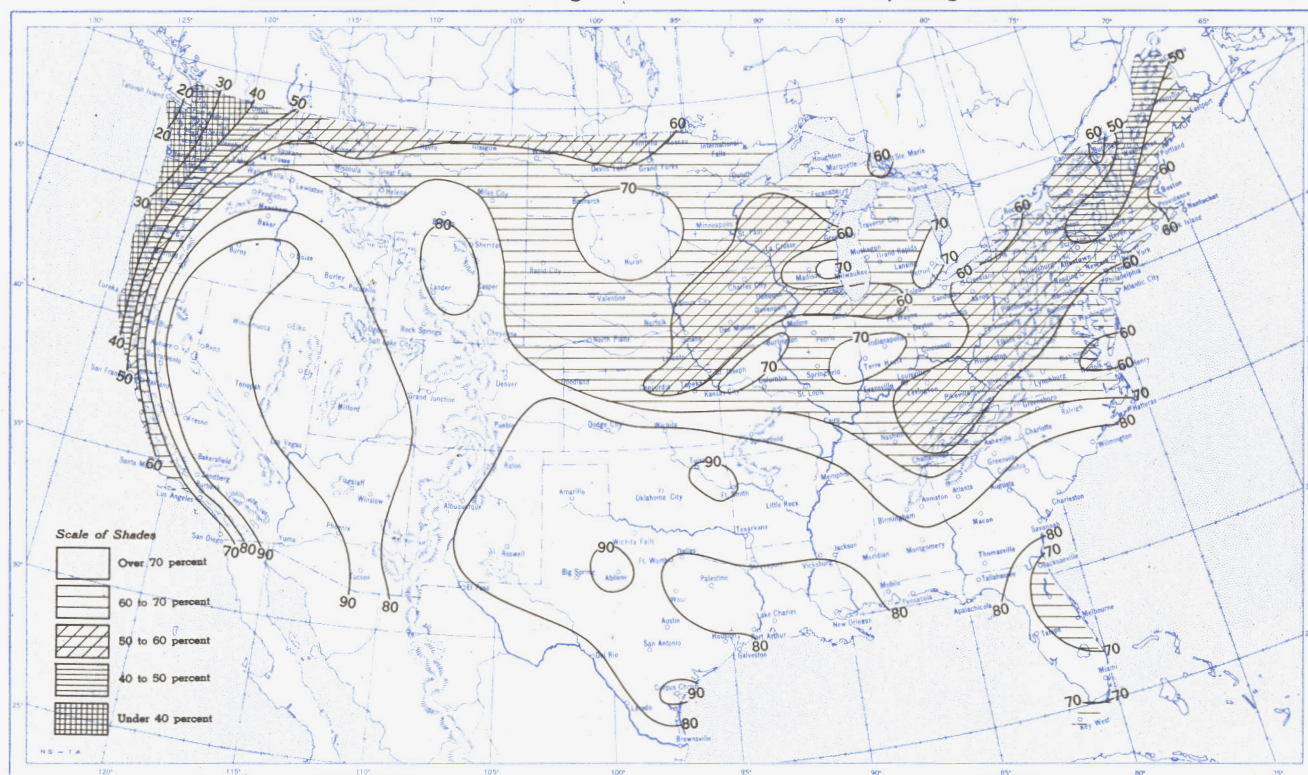


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, August 1954.

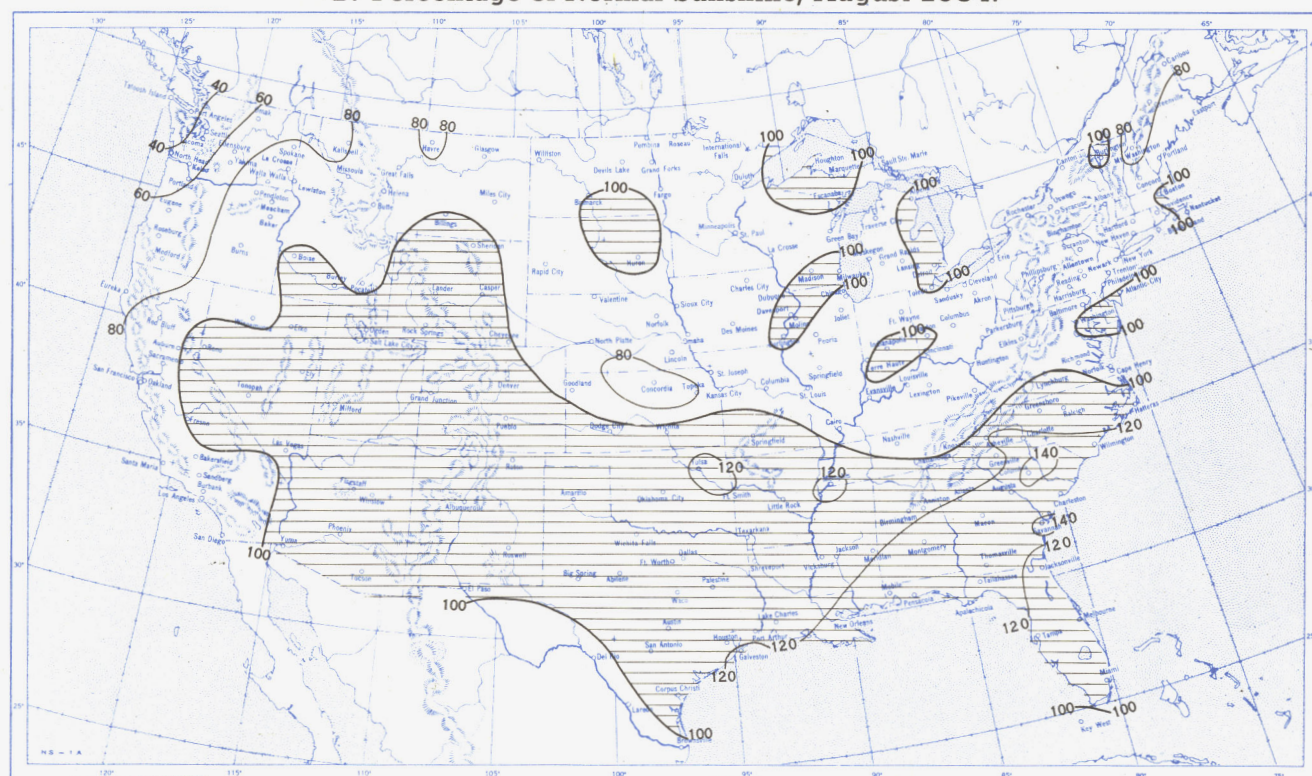


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, August 1954.



B. Percentage of Normal Sunshine, August 1954.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, August 1954. Inset: Percentage of Normal Average Daily Solar Radiation, August 1954.

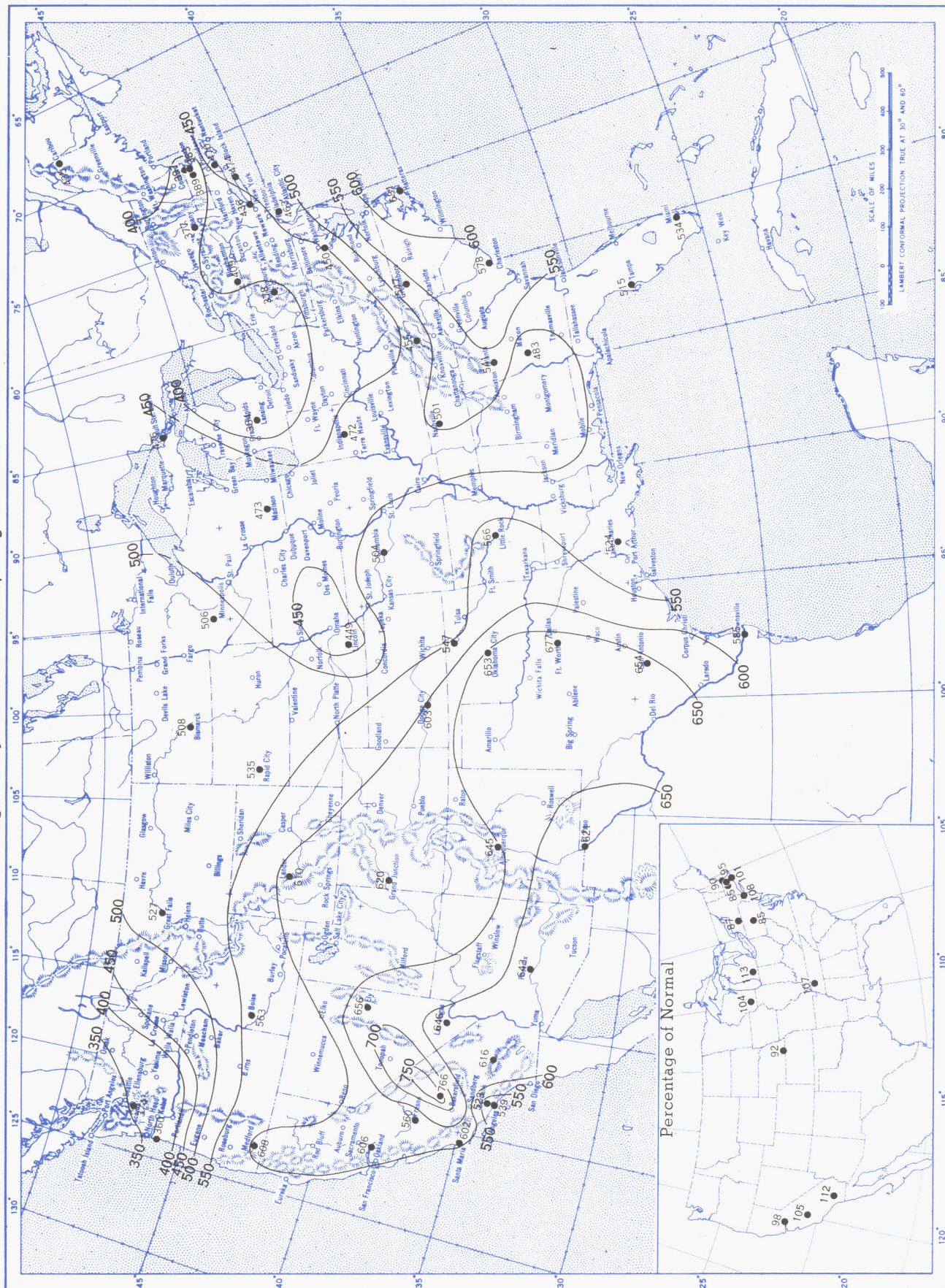


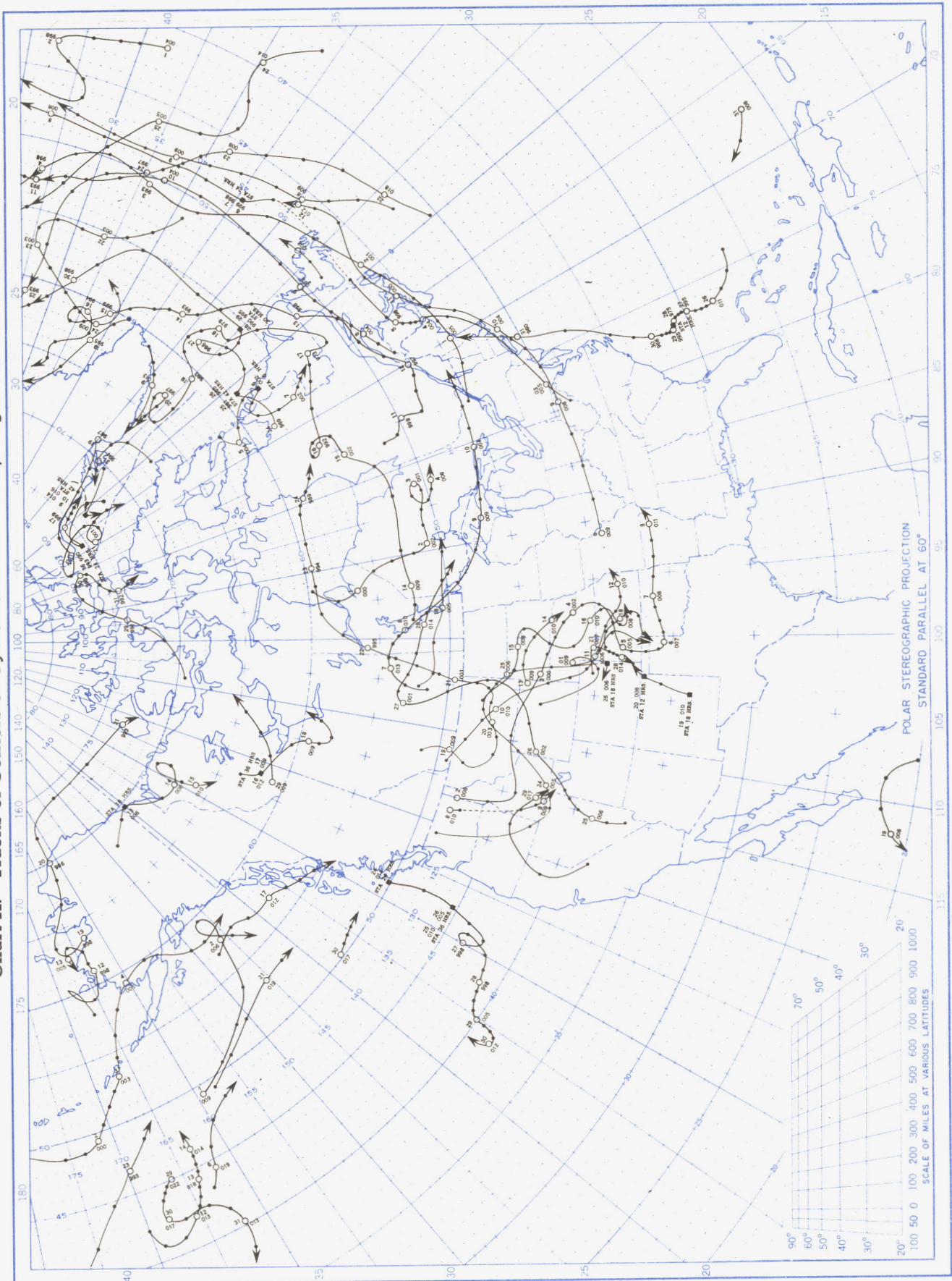
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langley's (1 langley = 1 gm. cal. cm. <sup>-2</sup>). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, August 1954.



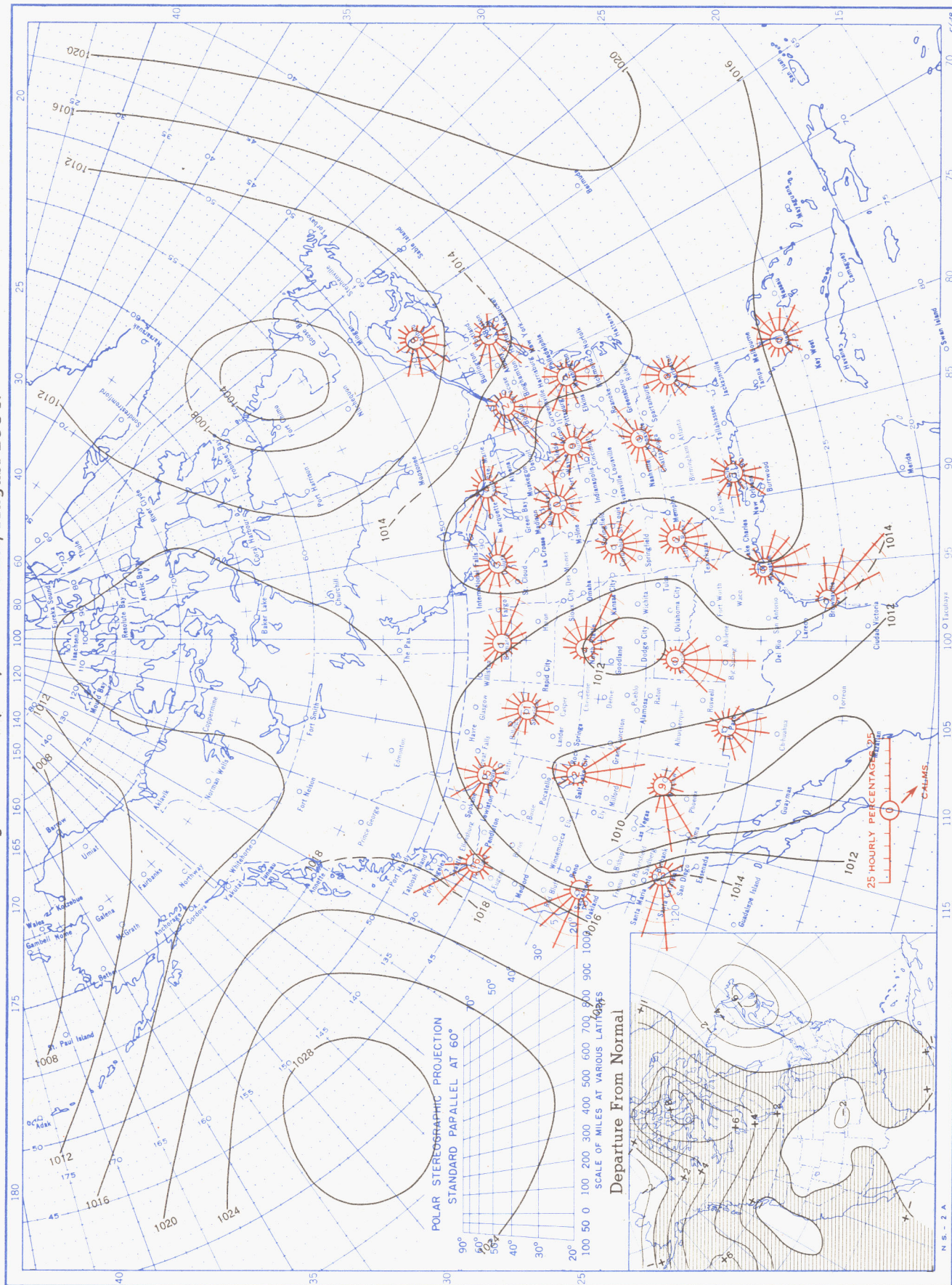
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, August 1954.



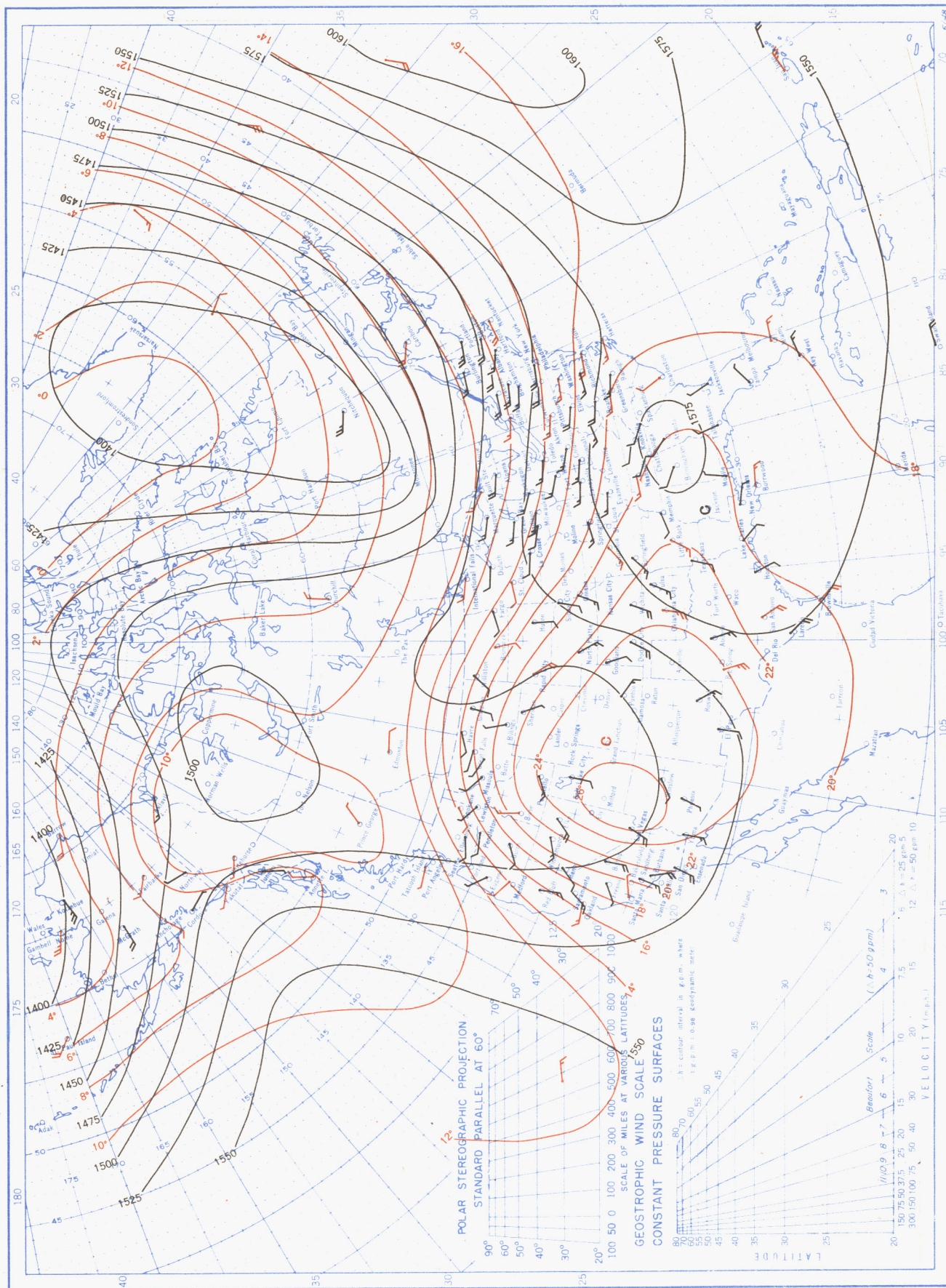
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, August 1954. Inset: Departure of Average Pressure (mb.) from Normal, August 1954.



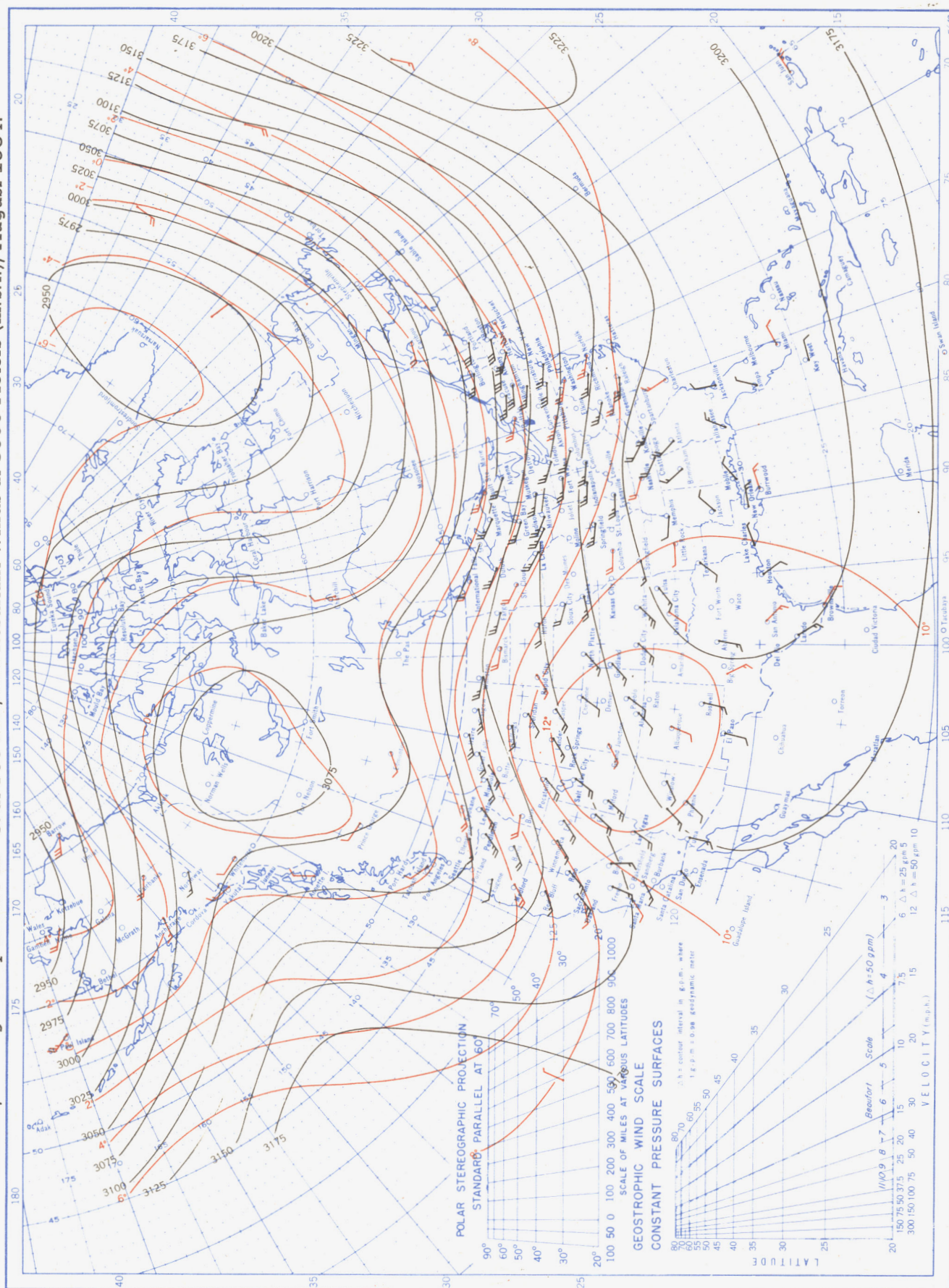
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° inter-sections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), August 1954.



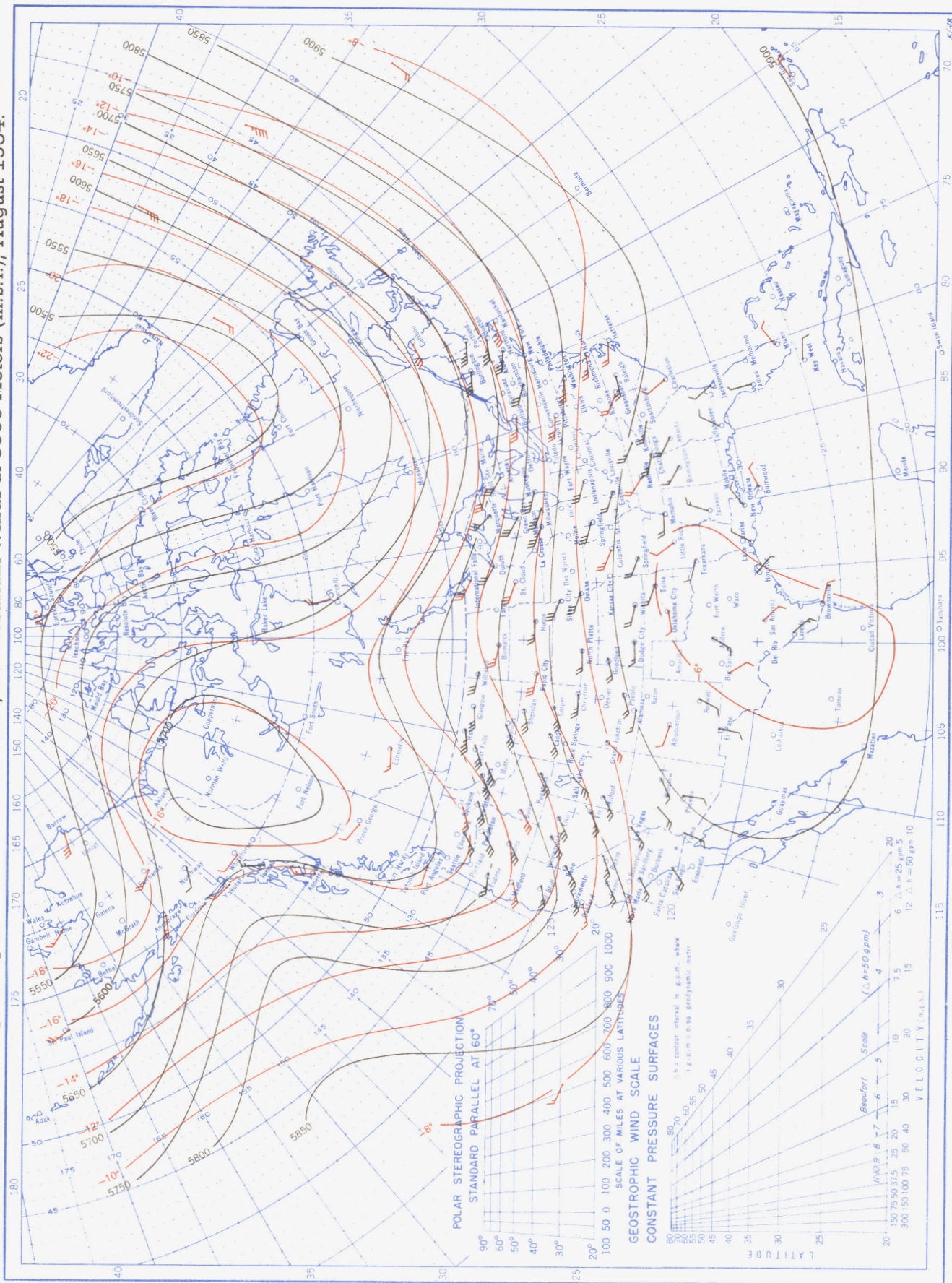
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), August 1954.



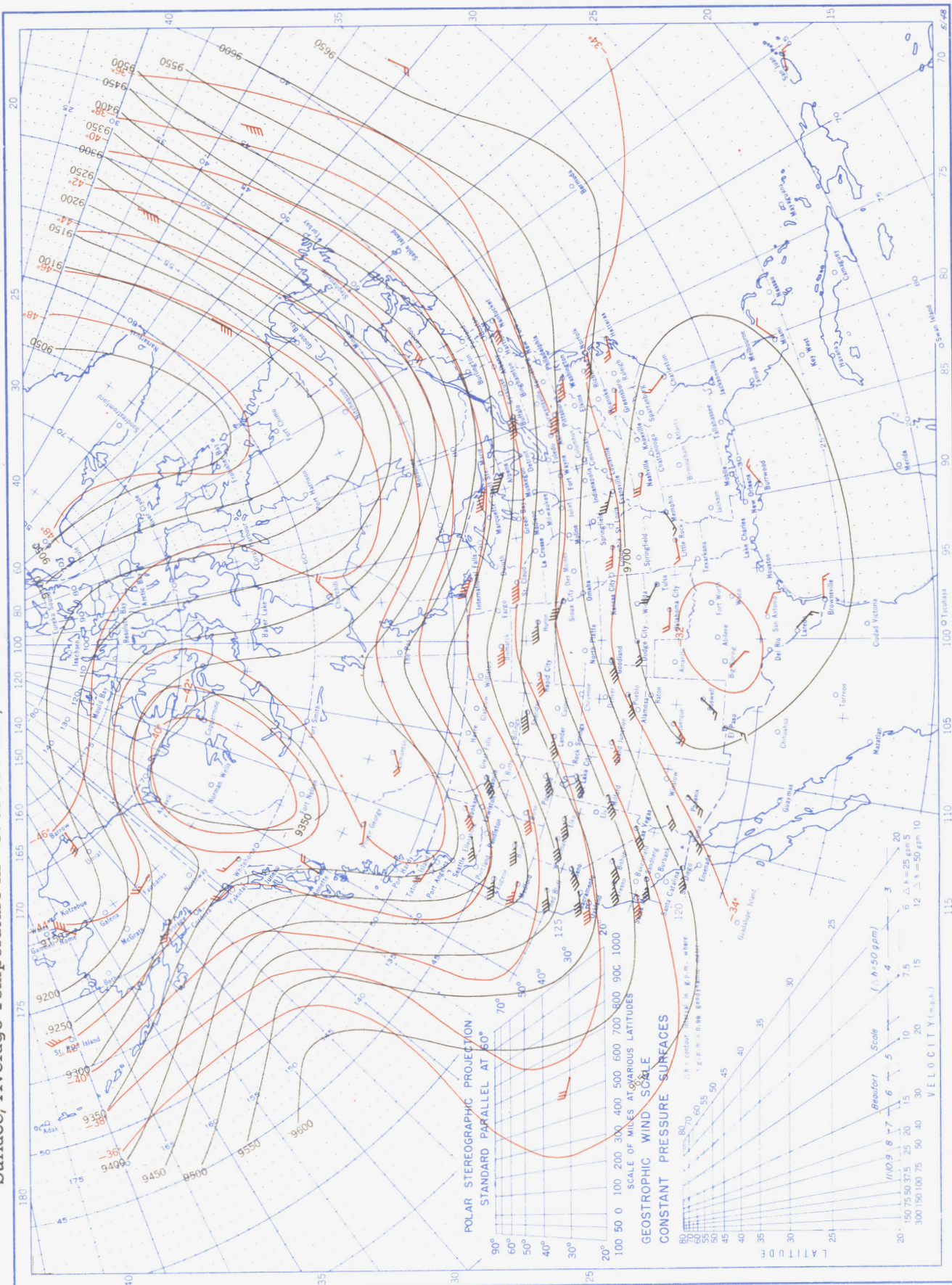
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawinsonde observations at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), August 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), August 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.